Clinical predictors of forearm fracture in children
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SUMMARY
This study was undertaken to try to define the best clinical predictors of forearm fractures in children aged 3 to 15 years. Over an 8-month period, 136 children attending the Accident and Emergency Department of the Mater Infirmorum Hospital were enrolled in the study and 67 fractures were diagnosed. Gross deformity, point tenderness and decrease in supination and pronation movements of the forearm were the best predictors of bony injury. Gross deformity was obviously the most predictive with a sensitivity of 95%. The risk ratios for moderate to severe point tenderness and decrease in rotatory movements were 3.4 and 3.2 respectively.

INTRODUCTION
The diagnosis of forearm fractures in children on the basis of clinical signs may be unreliable. It may be difficult to obtain a history and the very young may not permit examination. Even if the history and examination are easily obtainable, fear of the medico-legal implications of a missed fracture may interfere with clinical judgement and the decision as to whether or not radiographs are necessary. Therefore, we decided to exclude the very young and chose an age range of 3 to 15 years for the study. We looked at the main signs individually to assess their value as predictors of bony injury. Unlike previous published work (Brand et al., 1982; Rivara et al., 1986), we specifically looked at the individual components of movement in the forearm, i.e., flexion and extension at both wrist and elbow and forearm rotation.

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METHOD

Over an 8-month period all children aged 3 to 15 years presenting with an injury to the forearm were included in the study. Patient details were entered on a proforma by the triage nurse.

The proforma was then completed by the examining medical officer. If gross deformity was noted the rest of the form was ignored. For those with no gross deformity, both general or point tenderness were sought. The degree of tenderness was assessed according to whether the child winced or withdrew from finger pressure or would not allow palpation at all. These were taken to be a measure of mild, moderate or severe point tenderness respectively. Evidence of bruising or swelling was recorded.

The individual components of forearm movement were measured using a goniometer. The full range of flexion/extension in the elbow was taken to be 150 degrees. A decrease in movement of less than 50 degrees was taken as mild reduction, from 50 degrees to 120 degrees as moderate and more than 120 degrees as severe. Normal flexion/extension at the wrist is about 145 degrees and a reduction of 45 degrees or less was mild, between 45 degrees and 115 degrees was moderate and more than 115 degrees was severe. Normal rotation is possible through a range of 170 degrees. Mild decrease meant a reduction of less than 70 degrees, moderate between 70 degrees and 140 degrees, and severe was greater than 140 degrees of decrease in rotation. Thus, all signs were initially grouped as mild, moderate or severe. Radiographs were taken in all patients and the presence or absence of a fracture was noted, confirmation of the radiological diagnosis coming from a report by a Consultant Radiologist.

STATISTICAL ANALYSIS

The ability of each variable to predict fractures was measured using the risk-ratio method (Morris & Gardiner, 1988). This is an estimate of the risk of fracture among individuals exhibiting a sign relative to the risk among those without that sign. Ninety-five per cent confidence intervals for each risk-ratio were calculated. As the number of children with moderate or severe point tenderness and decrease in the various movements were small, these two grades were grouped together.

RESULTS

Of the 136 children included in the study, 65 (48%) had one fracture and one child had bilateral fractures giving a total of 67 fractures.

The results are shown in Table 1. Gross deformity was obviously the best predictor, 19 out of 20 with this sign having a fracture. The risk-ratio was not calculated for this sign because of its high sensitivity and because when this
Table 1. The number of children with or without a fracture in the presence of a clinical sign and the relative risk of fractures in the presence of that sign.

<table>
<thead>
<tr>
<th>Clinical Sign</th>
<th>Fracture (n=48)</th>
<th>No Fracture (n=69)</th>
<th>Relative Risk</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruising</td>
<td>5</td>
<td>24</td>
<td>0.4</td>
<td>0.2–0.8 *</td>
</tr>
<tr>
<td>Swelling</td>
<td>31</td>
<td>42</td>
<td>1.1</td>
<td>0.7–1.7</td>
</tr>
<tr>
<td>Point tenderness</td>
<td>(a) Mild</td>
<td>12</td>
<td>1.3</td>
<td>0.8–2.3</td>
</tr>
<tr>
<td></td>
<td>(b) Mod/Sev</td>
<td>22</td>
<td>3.4</td>
<td>2.1–5.7 *</td>
</tr>
<tr>
<td>Wrist Flex/Ext.</td>
<td>(a) Mild</td>
<td>17</td>
<td>1.6</td>
<td>1.0–2.8</td>
</tr>
<tr>
<td></td>
<td>(b) Mod/Sev</td>
<td>12</td>
<td>1.8</td>
<td>1.0–3.0 *</td>
</tr>
<tr>
<td>Sup/Pro</td>
<td>(a) Mild</td>
<td>15</td>
<td>3.2</td>
<td>2.0–5.0 *</td>
</tr>
<tr>
<td></td>
<td>(b) Mod/Sev</td>
<td>13</td>
<td>0.9</td>
<td>0.4–2.0</td>
</tr>
<tr>
<td>General Tenderness</td>
<td>12</td>
<td>49</td>
<td>0.1</td>
<td>0.1–0.3 *</td>
</tr>
</tbody>
</table>

* These clinical signs had a ‘p’ value of under 0.05.

clinical sign was present, the rest of the clinical signs had not been recorded. Therefore, it has been omitted from the table. The other signs showing significant predictive values were point tenderness and decrease in rotatory movement. These gave risk-ratios of 2.1 and 1.8 when the signs were mild in severity but became more predictive with risk-ratios of 3.4 and 3.2 when they were moderate or severe in degree. The other parameters had a much poorer predictive value and, indeed, bruising and generalized tenderness had negative predictive values.

DISCUSSION

Our results are similar to previous studies but we have examined the individual components of forearm movement. We have found that a decrease in rotatory movements is as good as point tenderness in predicting the presence of a fracture.

The protocol devised by Brand et al. (1982) would reduce the number of X-rays for upper extremity injury by 12% in patients more than 15-years old. Rivara et al. (1986) in his study on children between 1 and 15 years of age has shown that physical examination is predictive of fractures in extremity injuries in children and that in the absence of specific clinical signs the probability of a fracture is low.

Unfortunately, a direct comparison of our results with those of other studies is difficult because none have used the risk-ratio method to estimate the predictive ability of each clinical sign. Nevertheless, had we employed the less appropriate odds-ratio method, our results would have been similar to those from other studies. Although our study is quite small, we believe it has demonstrated the best clinical predictors of forearm fracture in children and shown that forearm rotation is a good predictor. A larger study along the same lines might well help in
developing a protocol for deciding whether or not radiographs are necessary in children with forearm injuries.

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REFERENCES